

We're BACK!! (in Reed & Curie Halls)

Physics Presentations at 2 National Meetings

Physics Students Present Class Research at ACSAT Student Showcase

Green Bank NRAO January, 2020

Dr. Liss and Students Present at Astronomy Meeting

Students Travel to Arctic to Deploy Own Research Projects

Students Present Arctic Research at Virtual Student Engagement Forum

Back Home Again!

We first shuffled around in Reed & Curie Halls in January of 2016, clearing the way in Curie Hall for the upcoming renovations. Then, in August of 2017, we moved completely out of Reed & Curie to spaces in the Library (offices, some research/work space), Walker Hall (introductory & upper-level teaching labs), and Preston Annex (research labs). Plus, we had the Planetarium in the Center for the Sciences. One department, 4 locations across campus – a confusing 4.5 years.

We are now back in our newly-renovated, permanent location. Our offices – and department office! – are on the 3rd floor of Reed Hall, along with 2 upper level teaching labs. We have a large research lab on the 2nd

floor of Reed, along with a dedicated Society of Physics Students (SPS) room! We have two large introductory teaching labs, with one hosting physics labs and one hosting astronomy labs and the Physical Science 350 hand-on science class for future teachers. We have a physics-only storeroom just across the hall from the introductory physics lab.

The ground floor of Curie Hall houses the wind tunnel research lab, and the Scanning Tunneling Microscope (STM) research lab.



Introductory Physics teaching lab, adjacent to same-size introductory astronomy lab.

Some pictures of the renovated Physics rooms



Physics faculty/student research lab; the SPS room is behind the wall on the right.



Curie-to-Reed Hallway to Physics Department showing how the whole building is much more open.



Wind tunnel research lab, adjacent to the STM lab.

Physics at Undergraduate Research Meeting

The Physics Department is part of 2 ongoing grants within the Artis College of Science and Technology. One of these is the Council on Undergraduate Research Transformations Project (CUR-TP). Faculty members attending the national meeting October 4-6 in Houston included Dr. Brett Taylor, Dr. Rhett Herman, Dr. Sandra Liss, Dr. Todd Rutkowski, and Dr. Michael Freed. They presented a poster they authored – along with Dr. Walter Jaronski and Mrs. Libby Watts – about our ongoing work to embed research practices throughout the entire curriculum.

RADFORD UNIVERSITY - PHYSICS YEAR 3 UPDATE AND SUCCESSES

CUR - TRANSFORMATIONS PROJECT

ACCOMPLISHMENTS

- Provided research learning outcomes for our degree and lower level courses
- Participated in the CUR-TP survey to share our success story
- Repeal implementation of two and addition of one new lab course for our current and upcoming students
- Developing a comprehensive way to track today with success from the implementation research skills and how to continue in the future

RU PHYSICS / AAPT RESEARCH OUTCOMES

1. Constructing knowledge
2. Modeling
3. Designing experiments
4. Developing technical and practical laboratory skills
5. Analyzing and evaluating data
6. Communicating physics

IMPLEMENTATIONS

CUR-TP SURVEY - INTERESTING RESULTS

• Develop our initial goals as we have a small number of respondents and only survey all respondents see they do very much like physics/physics.

Category	Very much	Some	Not much
Confidence in conduct new research	33%	70%	0%
Research experience increased skills in conducting research	43%	15%	42%
Confidence in research experience	55%	47%	36%

We have infused research skills into our introductory classes via multi-week investigative/open-ended labs, and by including VPython programming work as part of the curriculum. Thanks to the efforts of Dr. Rutkowski, we have mapped the skills presented in our labs to those listed in the “Research Outcomes” of the American Association of Physics Teachers. In our advanced classes these research skills take the form of semester-long Project Based Learning (PBL) activities, which are clearly-defined problems and tasks presented to the class that require the use of class content to address.



Physics at AAC&U Diversity/Inclusion Meeting

Two Physics faculty members attended the American Association of Colleges & Universities (AAC&U) STEM Ed meeting on November 7-9 in Chicago. They were joined by faculty members from both the Biology and Chemistry Departments, as well as Dean Rogers and Vice Provost Dr. Jeanne Mekolichick. Drs. Rutkowski and Herman presented their work to incorporate Project Based Learning into both introductory and advanced courses. This is part of the ongoing work with the HHMI Inclusive Excellence grant shared by the three departments.

Project-Based Learning in Physics - Seeing the physicist within

Todd Rutkowski, Postdoctoral Teaching Fellow, Rhett Herman, Professor of Physics
Department of Physics, Radford University, Virginia 24142

Why project-based learning (PBL)?

- Provides an opportunity for learning and expertise in
- Provides student self-advocacy
- Encourages multiple learning styles
- Research consistently
- Addresses the academic success of women, students of color, and our non-traditional students (2017)

Keys to Successful PBL Implementation

- Clearly state the goals and significance of the project to the students
- Provide context (history, culture, and/or social project significance) and be prepared to be part of the journey
- Scaffold objectives and due dates throughout the semester
- Provide formative feedback after each objective
- Emphasize how the skills they gain are applicable outside of class

Reducing the Skill Anticipation Gap for Freshman

Engaging freshman students has always been a challenge in the science world

- Students struggle to articulate why they are in college and why they are in the science world
- Students struggle to articulate why they are in college and why they are in the science world
- Addressing the gap between expectations and reality is a challenge
- Hands-on learning activities, self-reflection, and peer-to-peer learning
- Personal narratives as a key to success
- Hands-on learning activities, self-reflection, and peer-to-peer learning
- Personal narratives as a key to success

Geophysics - Geographical Site Survey

Performing a geophysical site survey of a 13-acre parcel in the New River Valley Community Park (NRVCP) in Dublin, VA

- Student team: “Senior Physics” and “Junior Physics” students
- Why this is important for the site: geophysical site survey
- Geophysical site survey: a key to success
- Geophysical site survey: a key to success

Thermodynamics - Building Energy Analysis

Performing a detailed energy analysis of a campus building

- Addressing a key challenge in the science world
- Addressing a key challenge in the science world
- Addressing a key challenge in the science world

General Physics - The Fun-Chart Challenge

Teams compete to program fun-generated charts to show off their skills

- Fun-generated charts: a key to success
- Fun-generated charts: a key to success

References and Acknowledgements

References: [List of references]

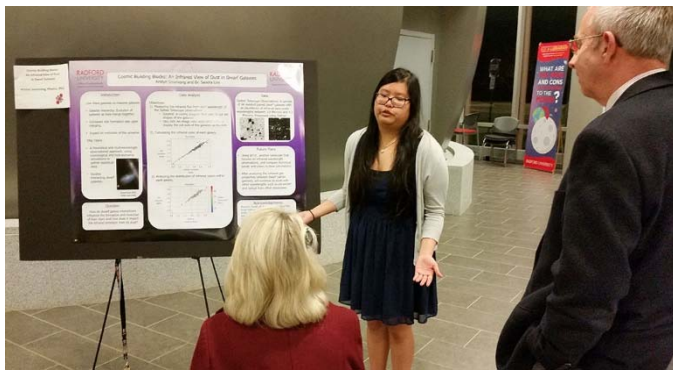
Acknowledgements: [List of acknowledgements]

Many of you have participated in some of these initial PBL efforts. We are working to continually refine this work with the goal of giving students skills and final products that they can put on their resumes. To help with this, at the end of the fall, we had a “resume session” in one of the final PHYS 221 labs to guide students through exactly where they put their Physics skills into the resumes. Students were pleasantly surprised to find that they already had marketable skills!



Physics Students Present at the Artis Showcase

The Artis College of Science and Technology held its annual Student Showcase in the lobby of the Center for the Sciences on Thursday, December 5, 2019. This highlighted student work throughout the College in both their research projects as well as in their classes. Below, Physics Major (Astrophysics Concentration) Krislyn Sourivong presents her ongoing research with Dr. Liss on the evolution of the dwarf galaxies orbiting our own Milky Way galaxy. She is talking with Mrs. Nancy Artis, who donated (with her husband Pat) \$5 million to fund 67 Artis Scholarships for students in the College.



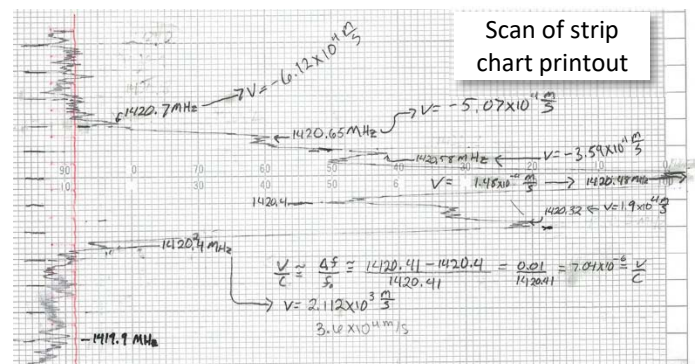
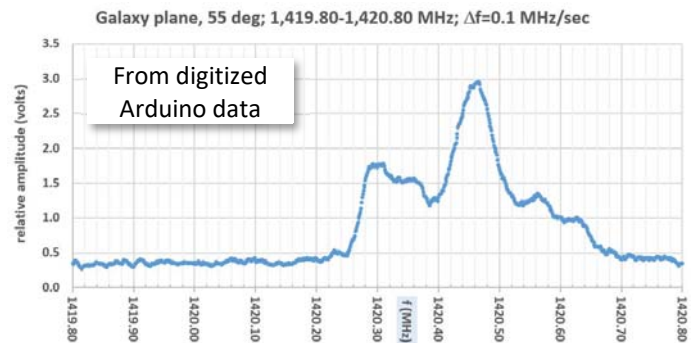
Above, May 2020 Physics graduate Roque Aguan presents his work with a microclimate sensor in the PHYS 301 – Meteorology (now Atmospheric Physics) class. He and his partner installed a lightning sensor along with various other humidity/temperature/pressure sensors on a sensor post designed to monitor possible ionizing effects of storms on the microclimate near a small stream.

Green Bank NRAO 2020

On the weekend of January 24-26 the Society of Physics Students traveled to the National Radio Astronomy Observatory at Green Bank, WV, to learn about radio astronomy. While there, the group had access to the 40-foot-diameter teaching radio telescope and used that to gather data. This year was a bit different. Dr. Liss used a lot of the data in her upper level ASTR 310 – Observational Astronomy class. We also had a home-made Arduino-based analog-to-digital converter that we used to try to digitize the scans. While not perfect, our

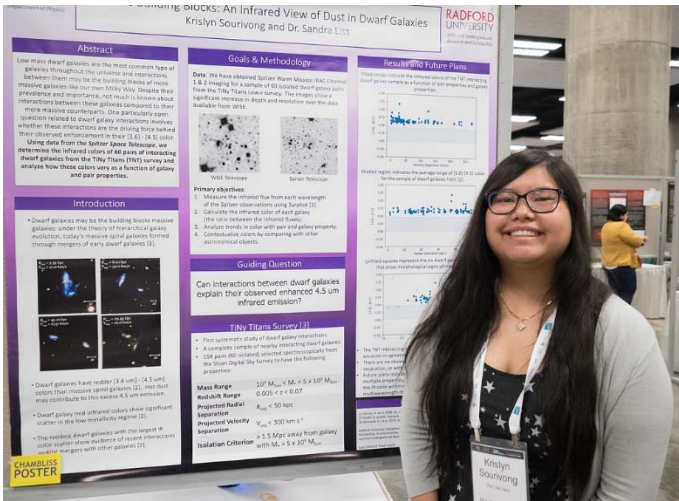


modest success led us to realize that we can improve the design and take it back next year.



Students Present at Astronomy Meeting

Dr. Sandra Liss and two of her students – Krislyn Sourivong and Michael Hess – traveled to Hawaii January 408, 2020, to present at the 235th meeting of the American Astronomical Society. Krislyn (below, with her poster) presented her work in analyzing data from the Spitzer Space Telescope as it studied 60 isolated pairs of interacting dwarf galaxies. She also studied how these pairs compared to other classes of galaxies.



Michael Hess (below, foreground/talking) presented his work on a 16-electrode homemade galvanic electrical resistivity array for geophysical surveys. He did this to show that such work gives students skills in instrumentation and troubleshooting that will be valuable in their future career path in astronomy, a field that is instrumentally intensive.



Dr. Liss also presented work that she did with another of our faculty members, Dr. Michael Freed. Her presentation focused on their work in "...restructuring our astronomy and physics classes through backward course design with a focus on creating an active and inclusive science community." Specifically, they are focusing on project-based learning, along with diversity, equity, and inclusion training for all our faculty members. This work was supported by grants from the Howard Hughes Medical Institute Inclusive Excellence program, and from the Council on Undergraduate Research (CUR).

Student Research in the Arctic

The "next generation" of the Arctic Geophysics Research Experience had a new format. The fall of 2019 saw the first offering of the new class, PHYS 324 – Arctic Geophysics Preparatory Seminar. In this class, students studied the arctic, and then created their own research question that could be addressed through some homemade sensor project. The students submitted the initial research proposals – without identifying information! – which the entire class (and instructor) critiqued and improved. The students then re-submitted their modified proposals, parts were ordered, and they started building their own sensor projects. Members of the "arctic class of 2019-2020" are shown below in the research lab as they solve a problem that one of the students was having.



Student Research in the Arctic

The research group traveled to Utqiagvik (ne' Barrow), Alaska from February 29-March 14. Unlike prior trips, equipment shipping issues (too long of a story for this newsletter!) delayed the start of the work until the end of this first week. However, with some "first-weekers" staying an extra day, their work was completed before they left. One of the new things that we had was an ice corer. This is shown below in its "manual" configuration, with a hand-crank handle. When the rest of our equipment arrived we used a battery-powered drill which made the work go much, much faster. This allowed cores to be obtained to be later analyzed for the presence of microbes as well as microplastics.



Other projects included the wind "friction layer" at various locations on the ice (below). Anemometers on a sensor pole collected plenty of (via the Arduino control box) at 5 heights to characterize the ice boundary layer.

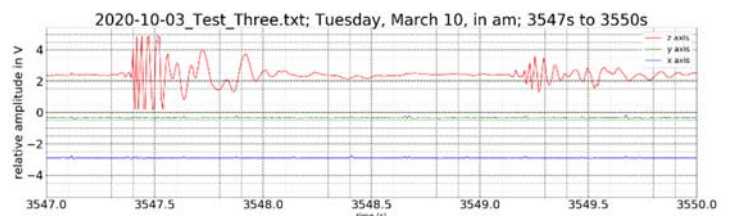


Special note: We are grateful for the financial support received from our alumni for this trip! A crowdsourcing campaign raised approximately \$4,500 to help alleviate the costs for the students on this year's trip. This will be a regular part of future campaigns, with 100% of the funds raised going to directly offset students' costs.

Another experiment involved putting a student-waterproofed pressure sensor into the seawater. The data was to be used to investigate potential correlations in tiny ocean pressure differences with the ubiquitous cracks forming in the ice. Below, Deanna Perales is getting ready to put her sensor into the seawater, with data to be obtained through her Arduino control box.



Yet another study involved a custom 3-d seismic sensor box. Designed and built from scratch by Hunter Witt, these boxes had 3 professional geophones whose signals were amplified by LT1677 op amps. These boxes returned copious amounts of seismic data since they recorded x-, y-, and z-values for vibrations over 140 times per second! They were left on the ice for up to 4 hours at a time, yielding up to 2 million 3d data points! One small portion of one of the scans is shown below, revealing the only-vertical displacement of the ice, and the dispersion in the wave.



Arctic Research at the Student Engagement Forum

This year's Student Engagement Forum (SEF) was virtual, as with so many things in this covid-changed semester. But the students did great with their poster preparations, and the results were impressive. Note that the research expanded to include more study fields.

Vertical Distribution of Microorganisms in Arctic Sea Ice
Katelyn Collett

Introduction
Microorganisms that live in sea ice are essential to the Arctic ecosystem and their habitat is constantly changing. They survive off the salty brine that is pushed back into the ocean as more ice freezes. The diversity of such organisms is great, but largely unexplored. It is in our best interest to gain more knowledge of these organisms so that we can make educated decisions in the future to protect the arctic ecosystem. Life is found in all parts of the ice, but the highest concentration of microorganisms is predicted to be at the bottom of the ice and decrease in concentration up to the surface. To investigate this, eight ice cores were taken from two different points of the shore of Ullapuk (formerly Barrow), Alaska, extending outwards towards the open water. Individual samples were obtained for later study at regular distances from the base of the cores.

Methods
An ice corer (pictured at right) was used to obtain 4-inch diameter cores from the sea ice. Slices shaped like "hockey pucks" were sawed from the cores at regular vertical intervals. These were kept frozen and were divided up into sample tubes (while still frozen). Those frozen tubes were not refrigerated during the ~70-hour trip back to Virginia, but they were likely frozen for most of that trip. After our return, the plan to process and analyze the samples was paused indefinitely due to the extenuating circumstance of the Covid-19 pandemic. All of the samples would have been stained using a Gram stain and observed under a microscope. To determine the microorganism concentration, the number of visible organisms would have been counted at five different spots on each sample and then averaged. The counts for each section of the core would be compared to check for consistency. The sections (where they were taken from the core) would be compared to see if any area of the core tends to contain more microorganisms.

The ice itself was a very rough terrain. As such like hiking a rocky trail, it took a lot of careful maneuvering to get to our sample spots. There were completely flat spots spread out over the ice. Our team targeted these spots for sampling as we worked our way away from the shoreline.

The ice corer could be used by hand or with a drill attachment. It also came with an extender that we used to go completely through the ~1.5-m thick ice. Getting the ice core took ~25 minutes by hand, but only took ~5 minutes with a battery-powered drill.

The most tedious parts of this research project was taking the core slices and cutting them up into small enough pieces to fit in the sample tubes. We filled over 100 50-millimeter tubes by hand with ice pieces. The image above shows how our "production line" processed the samples to keep the ice frozen and minimize contamination. There was no other option than carrying the samples back to Virginia on the plane. However, it was observed that very little melting actually occurred by end of the return trip. The image below shows all of the tubes that are currently residing in my freezer, unopened, until circumstances allow.

Three out of the eight cores were drilled by hand while the other five employed a drill. As seen in the picture, the core did not come out as one whole piece. This someone would often have to reach down into the hole and pull it out.

Other posters may be found here:

<https://portfolium.com/discover/tag/RUSEFArctic>



Dr. Rutkowski is Moving On!

We have been excited to have HHMI Teaching Postdoc Dr. Todd Rutkowski with us these past 2 years. During that time he has taught several classes with us, and has worked to overhaul both the calculus- and algebra-based introductory physics classes. His modifications include adding multi-week labs, incorporating metacognition into the curriculum, and including a number of student-centered aspects to the class (e.g. mandatory professor drop-ins to get to know students, etc.). Here at the end of his 2-year postdoc position he has accepted a physics teaching position "just up the road" at Washington & Lee University. We are grateful for Dr. Rutkowski's contributions to our curriculum, and wish him the best in his new position.

An Updated Curriculum

We have reworked our curriculum to better reflect the changing job and educational needs of our students. We now have 4 concentrations:

- Experimental & Theoretical Physics – for those who are going to graduate programs in physics or related areas.
- Astrophysics – for those going into astronomy or fields that use the skills common in this area. Recall that, even at the height of the Great Recession, the unemployment rate for those with this degree had a 0% unemployment rate (see Georgetown Center for Education & the Workforce).
- Biophysics – for those who want to go into the exciting field of medical physics. This concentration includes 2 years each of Chemistry and Biology classes.
- Physics Teaching – for those who want to take their degrees into the K-12 classroom and enjoy a rewarding career.

A Record Number of Dual Degrees

In the years that we have had the Dual Degree program with Virginia Tech's College of Engineering, we have had a small but steady stream of Dual Degree recipients. But this year saw a record number of these graduates earn both their RU Physics degree and their Virginia Tech Engineering degree. We had one person formally finish in December, and then 5 (yes, really!) graduate in May. Congratulations to all of these students for this amazing accomplishment.

Yet Another Success Story

Just one more big **THANK YOU** to everyone who contributed to the Arctic Geophysics crowdsourcing fund this year. You helped raise approx. \$4,500 for the students in this year-long research experience in its new format, and we are certainly grateful. You made all the difference in the world for these students, and you are greatly appreciated.

Contact Us

Let us know how you're doing, what you're doing, and where you're doing it!

Update your information here!

<https://www.radford.edu/content/csat/home/physics/alumni.html>

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